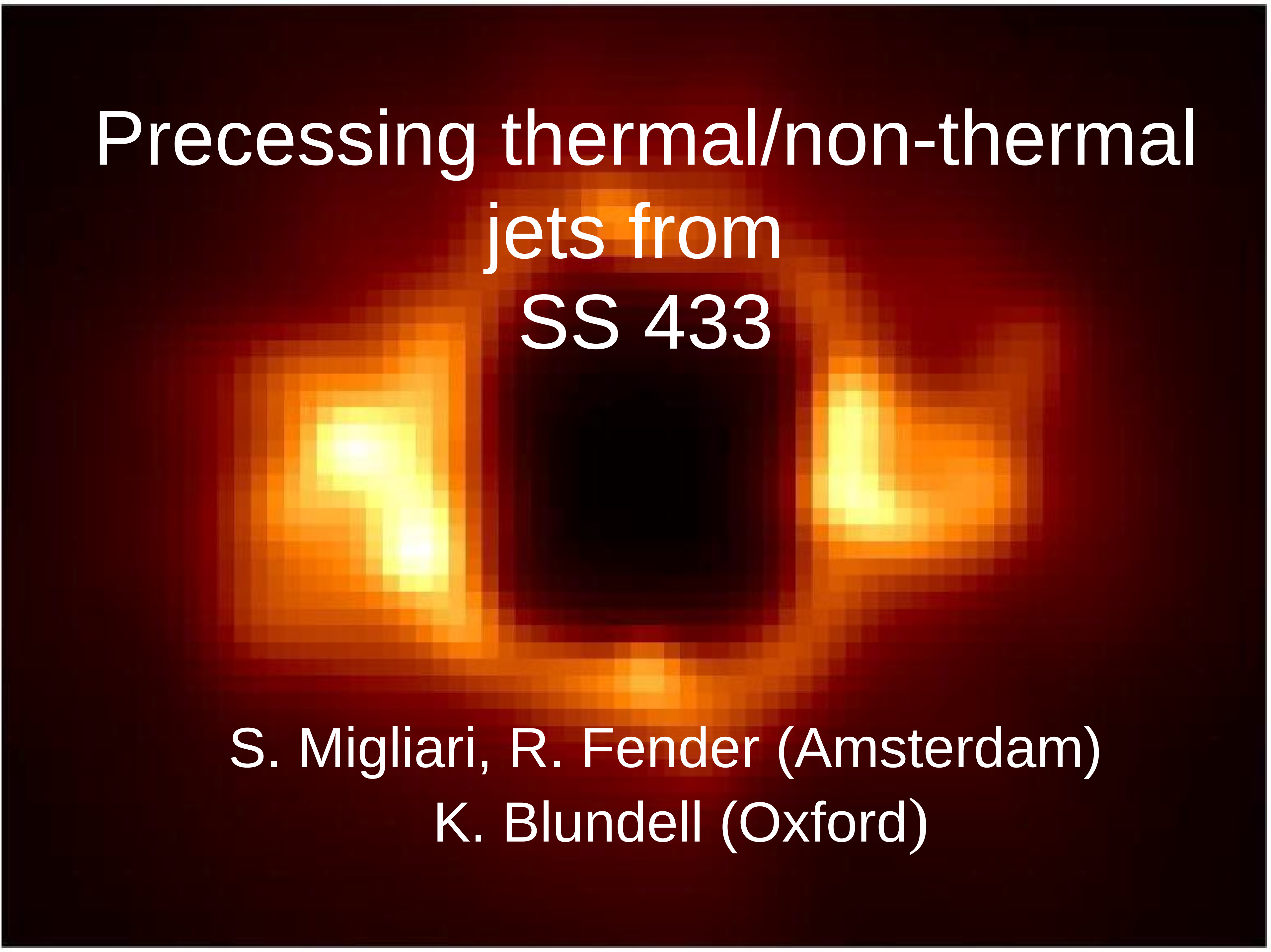
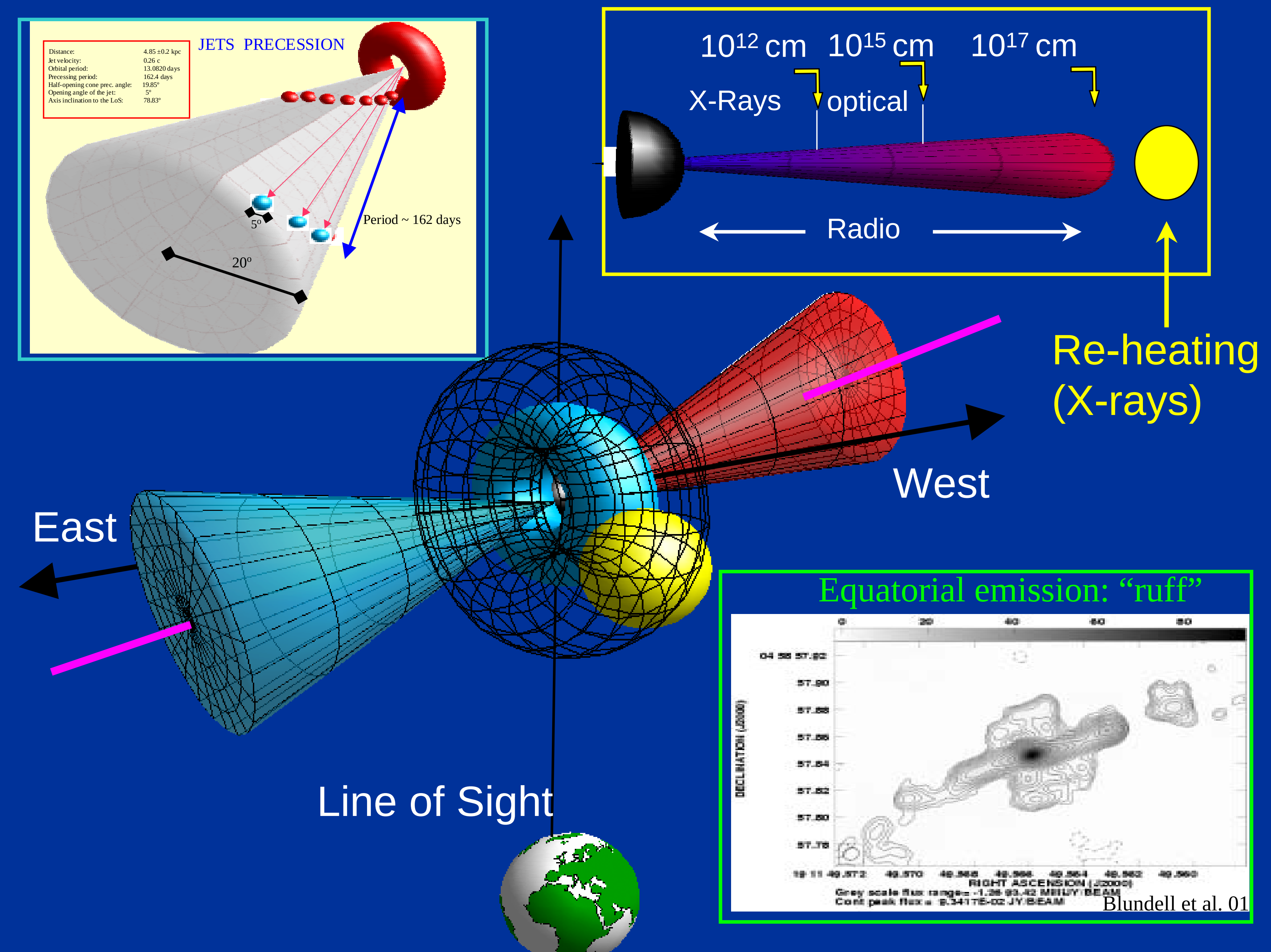
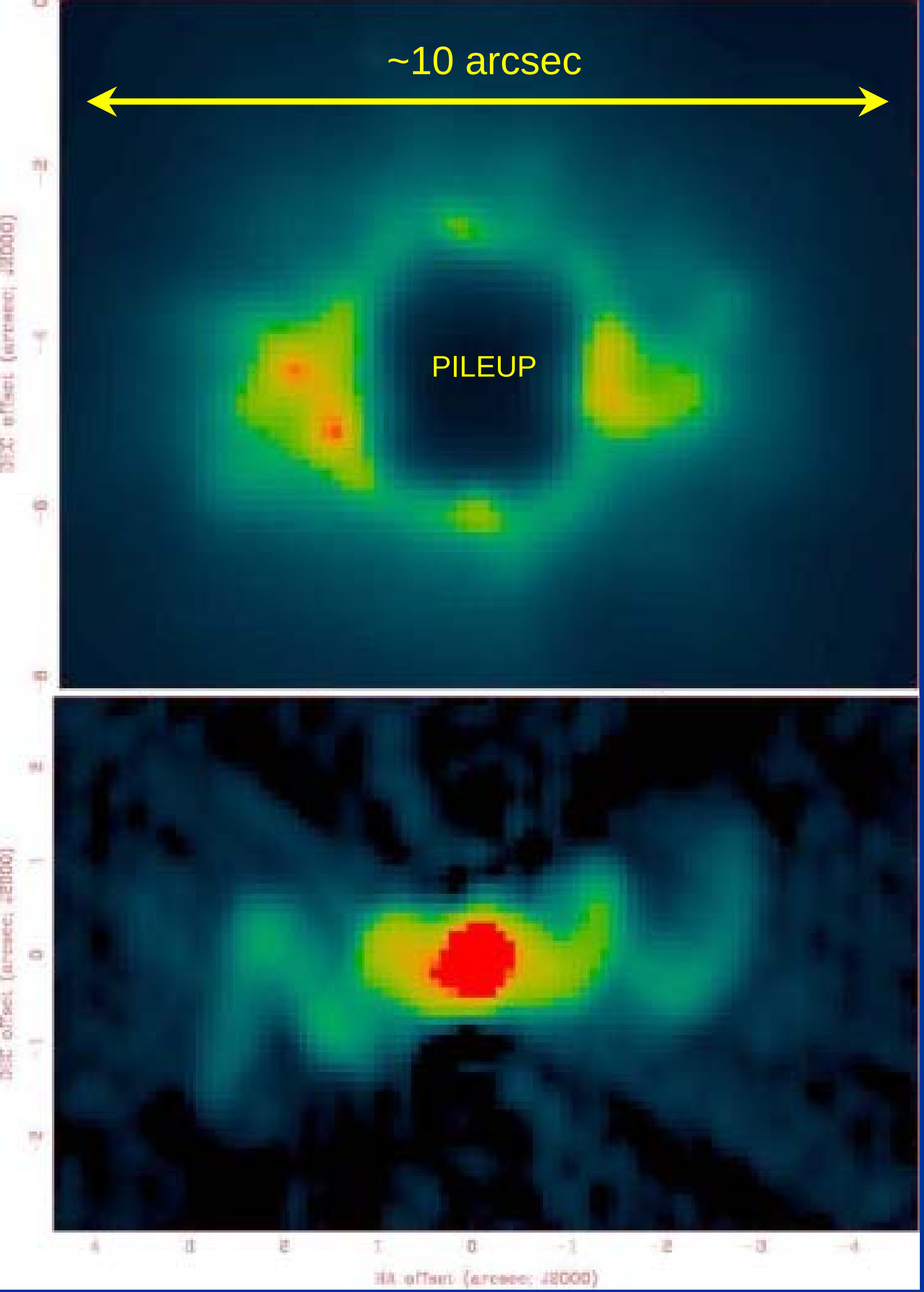
Precessing thermal/non-thermal jets from SS 433



S. Migliari, R. Fender (Amsterdam)
K. Blundell (Oxford)



JETS PRECESSION
Distance: 4.85 ±0.2 kpc
Jet velocity: 0.26 c
Orbital period: 13.0820 days
Precessing period: 162.4 days
Half-opening cone prec. angle: 19.85°
Opening angle of the jet: 5°
Axis inclination to the LoS: 78.83°
5°
20°
Period ~ 162 days
10^{12} cm
10^{15} cm
10^{17} cm
X-Rays
optical
Radio
Re-heating
(X-rays)
West
East
Line of Sight
Equatorial emission: “ruff”
RIGHT ASCENSION (J2000)
Blundell et al. 01



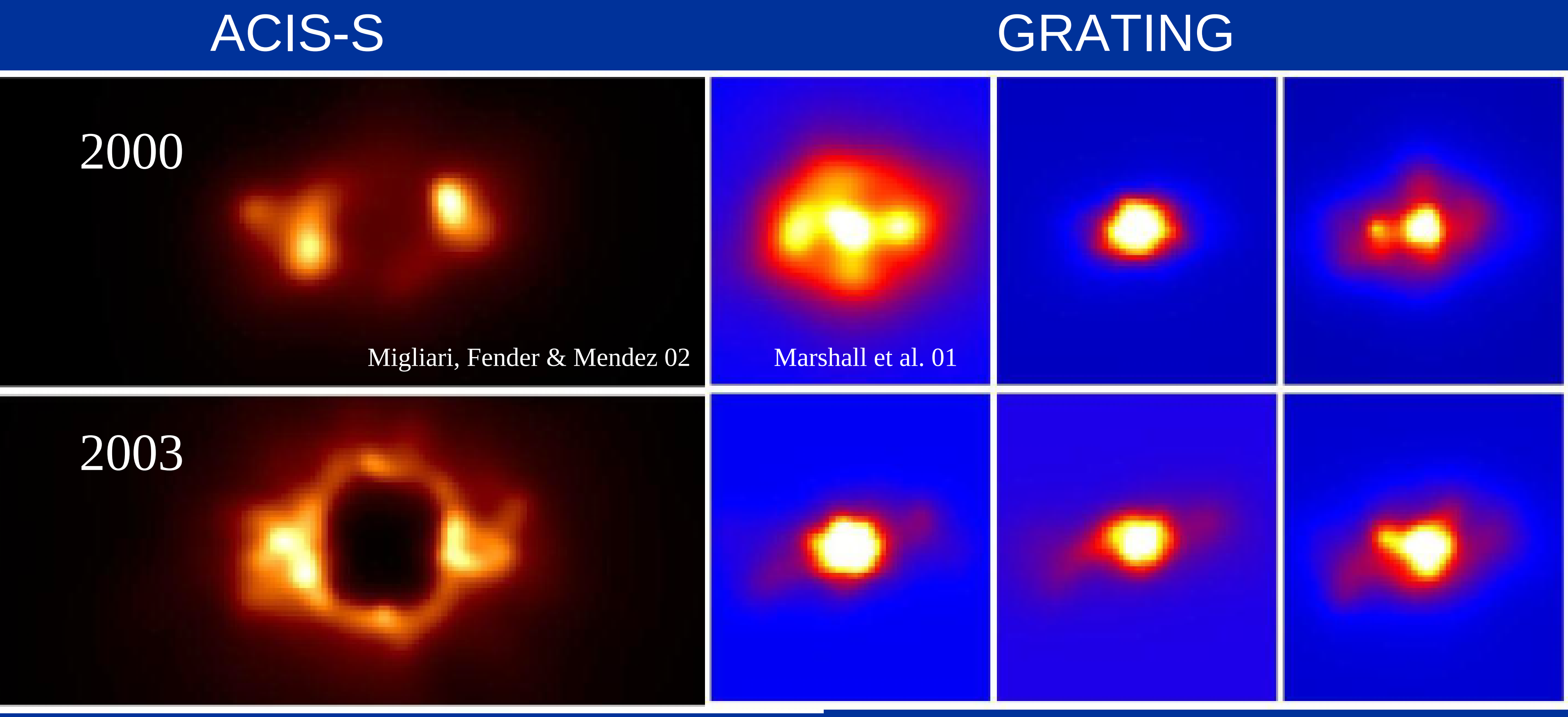
Simultaneous radio/X-rays

11 July 2003

60 ks of Chandra ACIS-S

40 ks of VLA @ 5 GHz

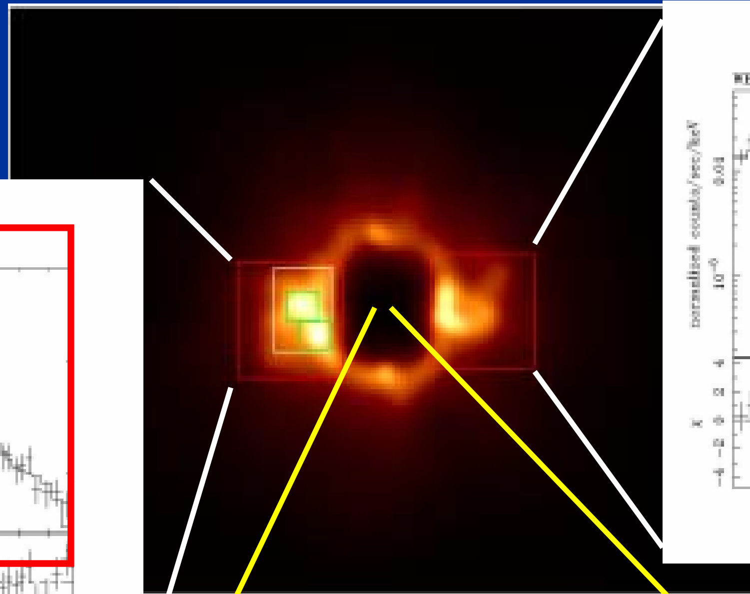
Arcsec-scale X-ray structure

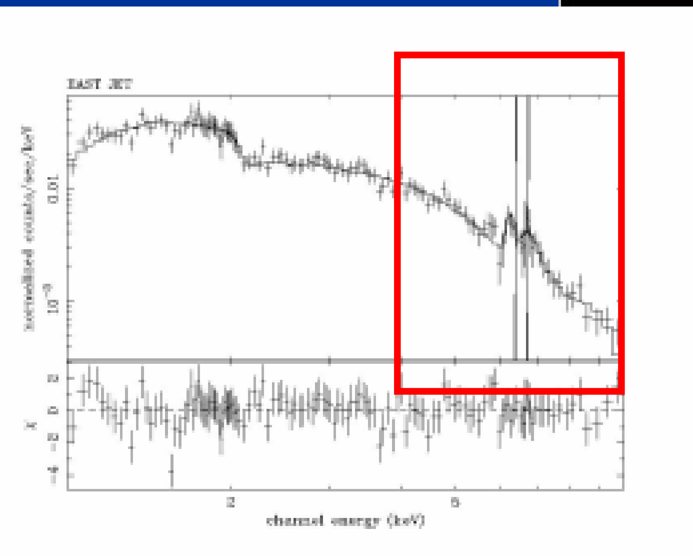


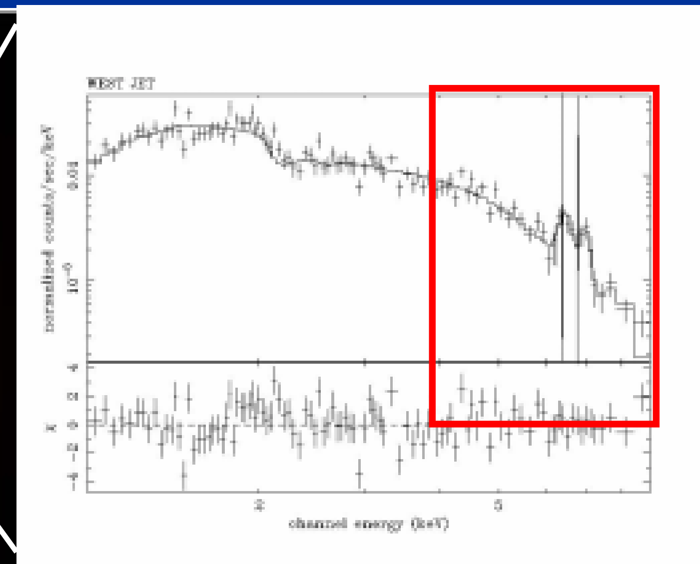
NOT a long-term and static structure

X-ray spatially resolved spectra

Vertical lines are @ 6.4 and 6.7 keV

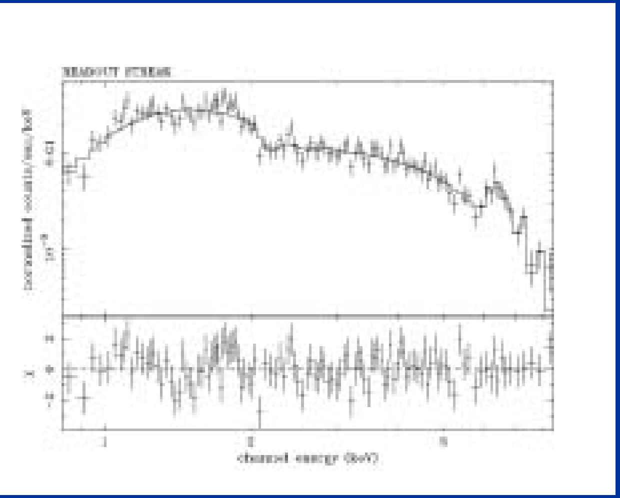






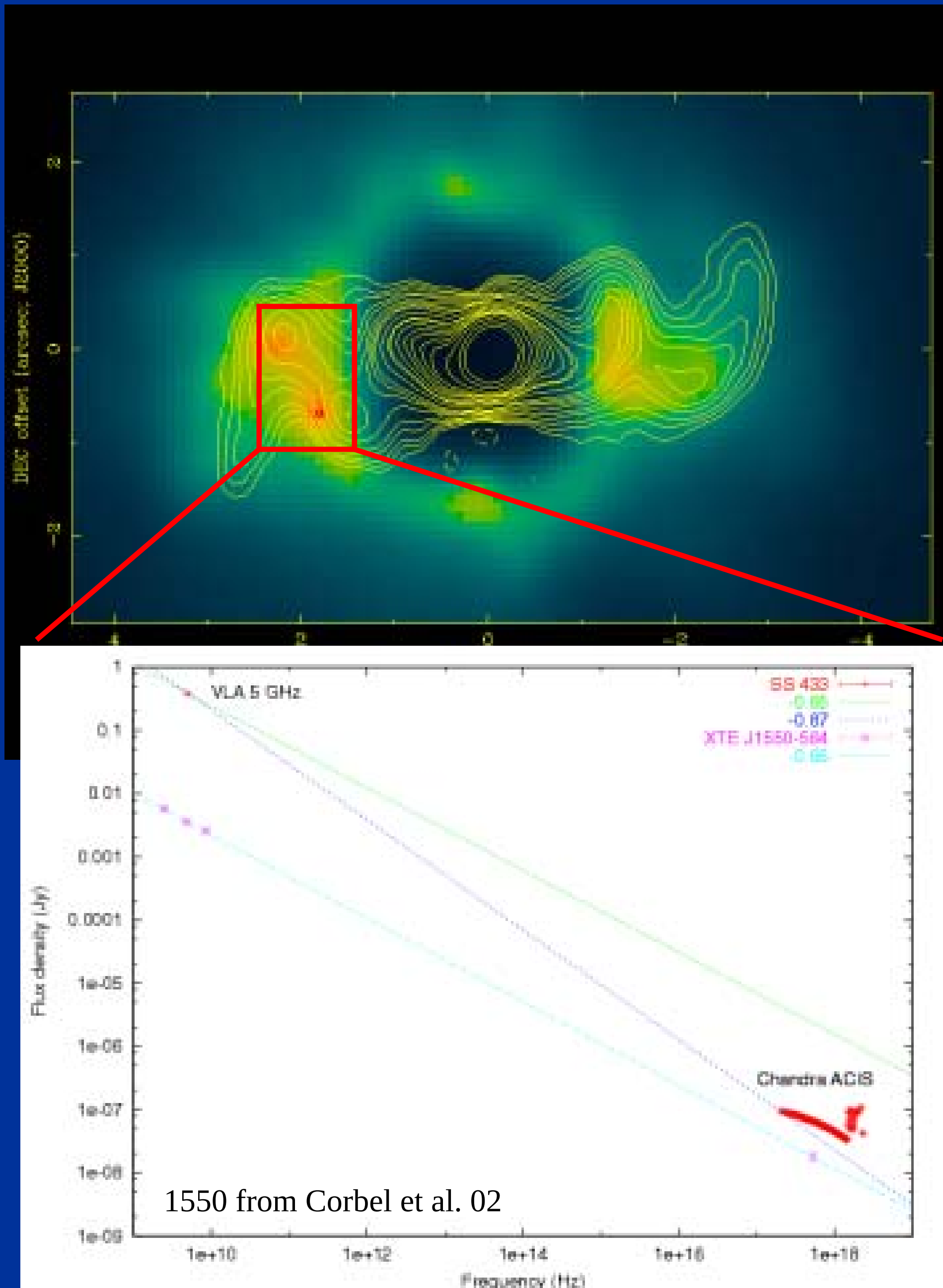
Multiple X-ray lines with different energies East-West

High excitation lines (Fe XXV / XXVI ?)



This indicates HOT, MOVING plasma at large distances from the core (100s of days since launch)

SIMULTANEOUS RADIO/X-RAY IMAGES



X-ray and radio emitting regions are spatially close (if not coincident)

X-ray continuum is NOT consistent with being produced by synchrotron (c.f. XTE J1550-564)

- break in the synch. emission before soft X-ray band
- X-ray continuum is thermal

SIMULTANEOUS RADIO/X-RAY IMAGES: estimating the relative populations of a hybrid thermal/nonthermal plasma

- We can estimate the volume of the east-jet in the region analysed
V~ f x 7x10e49 cm^3 (f is the `filling factor')

- From the volume and X-ray fluxes (Fe and bremss. continuum) we can estimate in two ways the baryonic mass that emits thermally:
→ M(br)~7x10e-5 Mo
M(Fe)~2x10e-5 Mo
The corresponding kinetic power is Lkin~2x10e41 erg/s

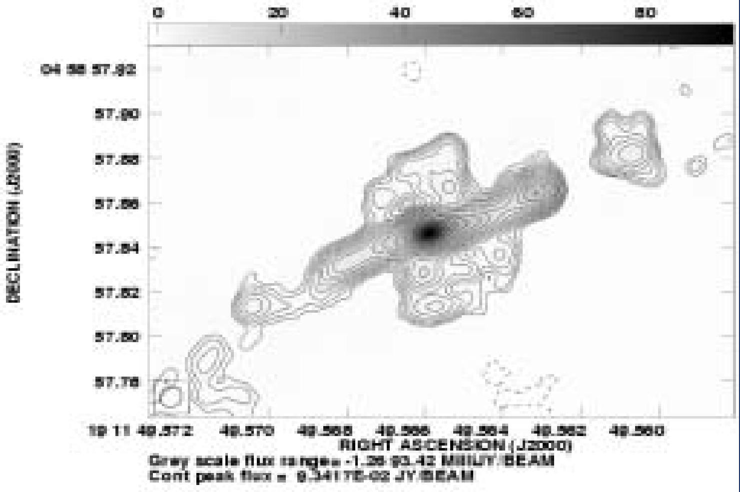
- From the volume and radio flux, from 'minimum energy' arguments and assuming that the particle distribution extends to Lorentz factors ~1 and one proton for each electron, the baryonic mass that emits synchrotron is:
M(synch)~ 10e-7 Mo

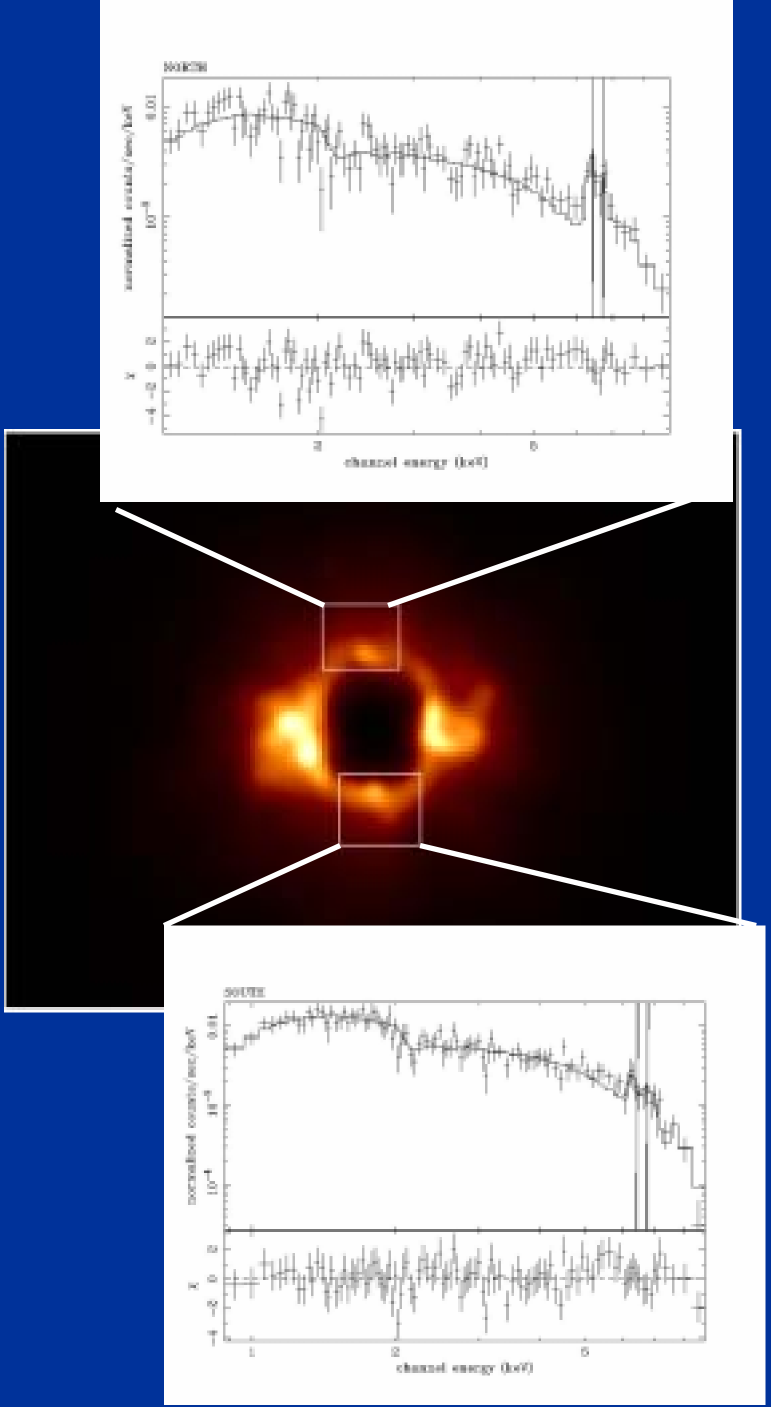
IF f~10e-6 we obtain a 'reasonable' value for a stellar mass obj. accreting at Eddington of Lkin~2x10e38 erg/s

IF we use the same filling factor for synch. population we obtain: Mx/Mr~50
THE MASS OF THE TAIL THAT PRODUCES SYNCH. IS ~1%

“RUFF”

(Equatorial emission)





- X-ray equatorial emission

- Iron lines: it seems to be a massive baryonic outflow of matter perpendicular to jets

Summary

- X-ray arcsec scale jets are NOT static and long term

- X-ray jets spectra: multiple Doppler-shifted Fe lines: hot (~keV) moving plasma at large distance from core

- Broadband radio/X-ray spectrum indicates hybrid thermal/non-thermal plasma with at most ~1% of total mass in non-thermal component

- “Ruff” seems to be a massive outflow perpendicular to the axis of the jets